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Effects of Tide Gate Upgrade or Removal on Fish Passage and Habitat Quality: A Literature Review and Knowledge Synthesis

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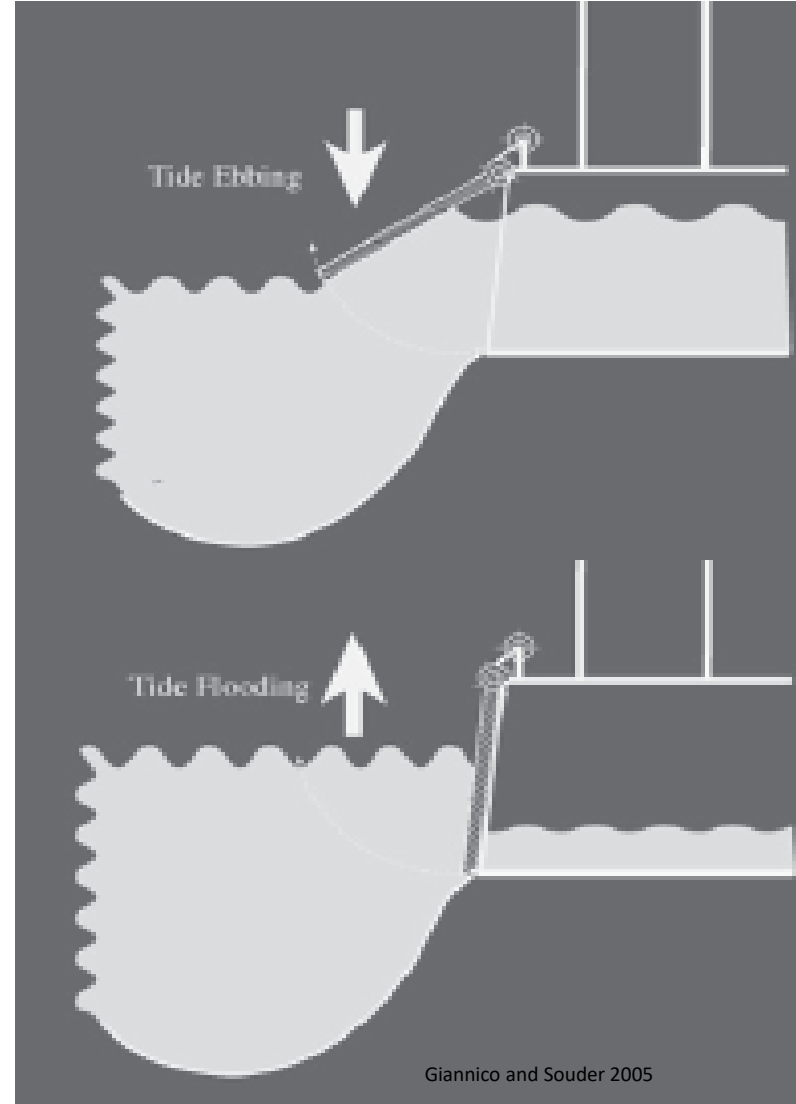
What is a tide gate?



Side Hinged



Top Hinged

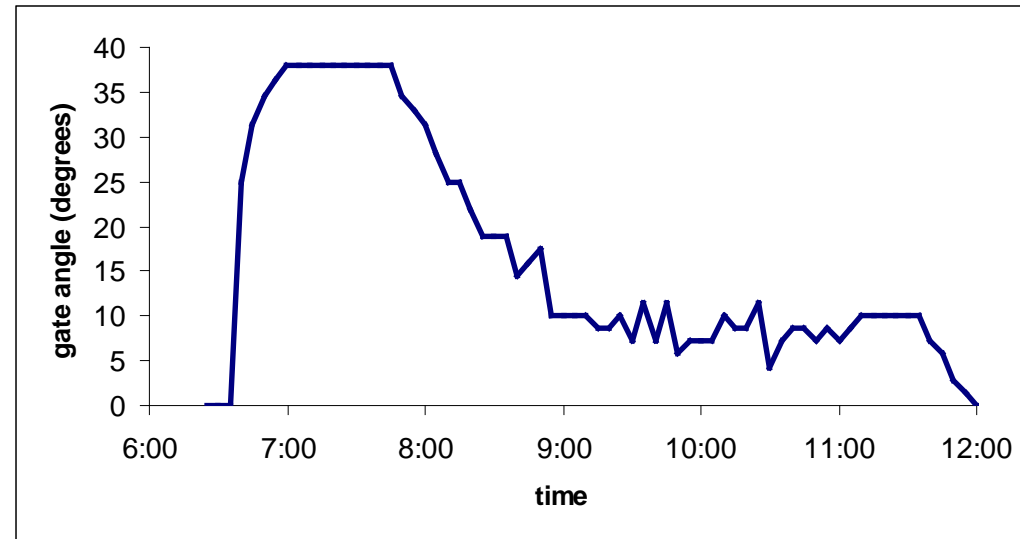


Tide gate function is determined by hydraulic head differential.

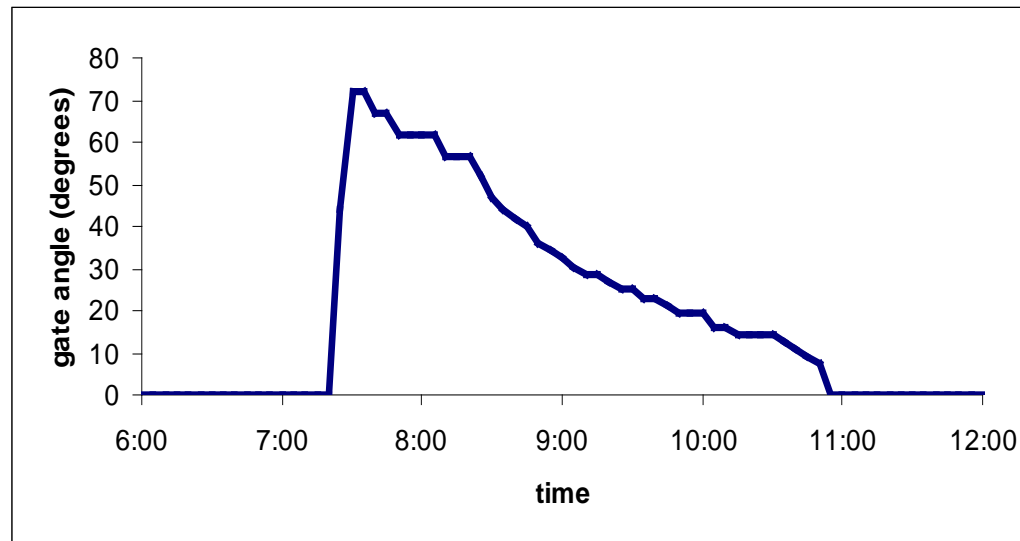
Top Hinged vs Side Hinged



Palouse 5/27/09 8:14



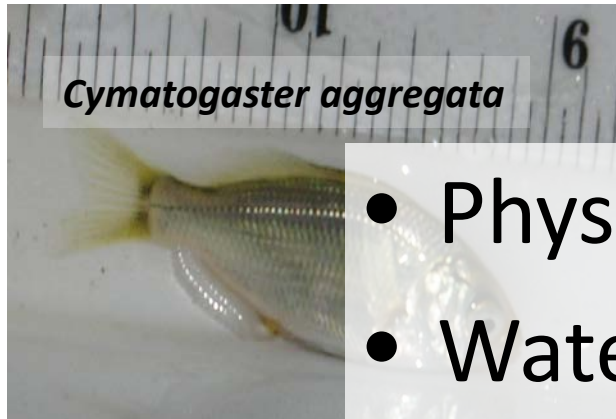
Larson 5/27/09 8:01



Self-Regulating Tide Gates



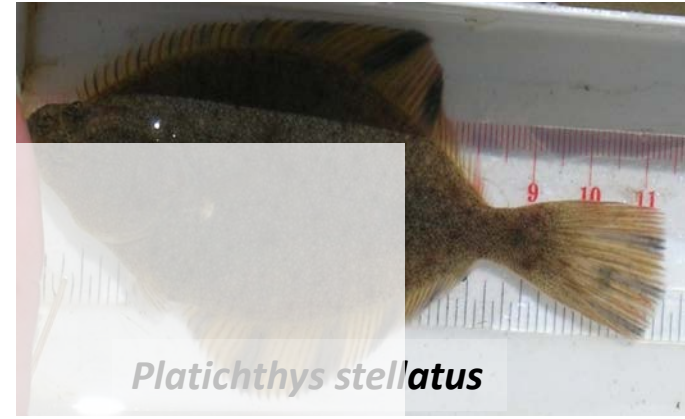
How tide gates affect fish



Cymatogaster aggregata

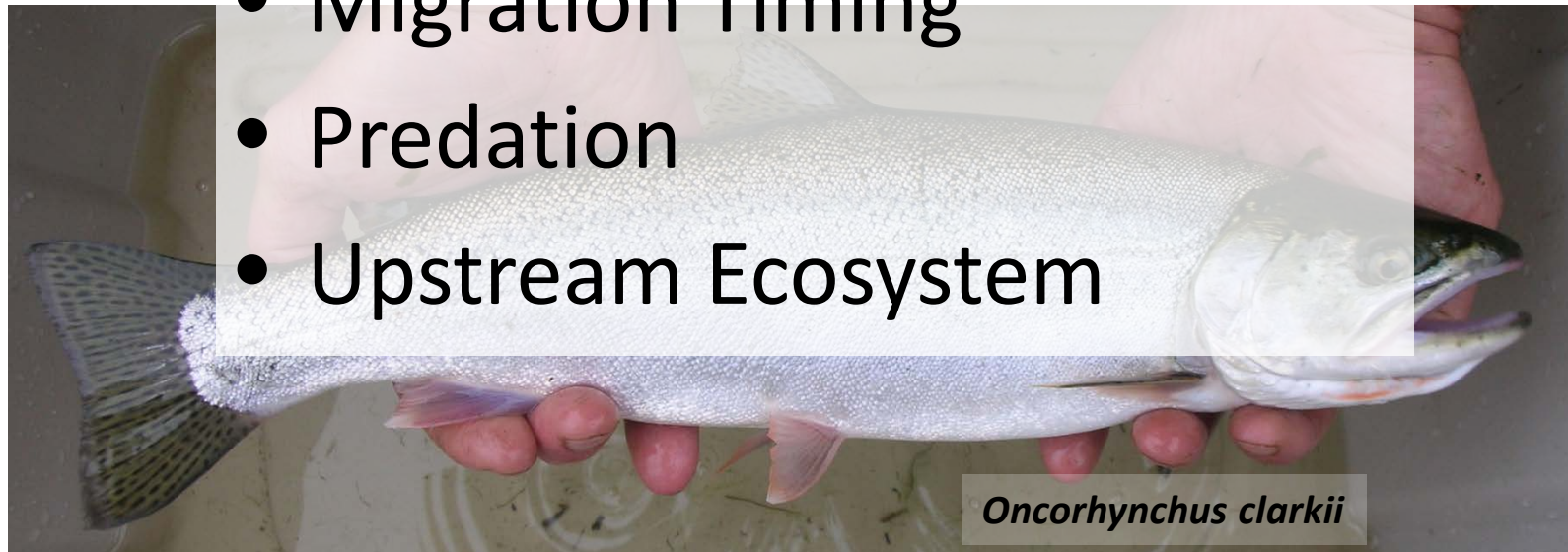


Sygnathus leptorhynchus



Platichthys stellatus

- Physical Barrier
- Water Quality
- Migration Timing
- Predation
- Upstream Ecosystem



Oncorhynchus clarkii

Project Request and Funding

- Oregon Watershed Enhancement Board (OWEB), administers lottery funds to be used for watershed and salmon habitat restoration.
- Funds tide gate removal and upgrade projects.
- Requested information on the effectiveness of such projects.

Main Tasks

- Review of primary literature regarding tide gate removals and upgrades
- Summary of results of tide gate removal and upgrade reports
- Findings and recommendations

Literature Review

Focused on following questions:

- Does tide gate upgrade or removal affect salmonid abundance, distribution, growth, survival or habitat availability?
- Does tide gate upgrade or removal affect water temperature, salinity, dissolved oxygen and tidal exchange?

Literature Review

Resources found:

- 350 initial results from systematic searches using Web of Science and Google Scholar.
- 65 potentially relevant publications from around the world
- 15 other publications found through other means
- 32 qualified to be used in literature review
- Also used project completion reports from the Pacific Northwest (British Columbia to Northern California)

Challenge

- Few studies examined effects of tide gate upgrades or removals independently of other restoration actions.



Results

- Finding 1: Limited connectivity associated with old tide gate installations significantly affects fish community composition and water quality.
- Finding 2: No tide gate is entirely fish friendly, they all have some impact on passage of aquatic organism.
 - Some side-hinged gates (SRTs type) may open for longer periods but they still interfere with the daily movements of salmon fry and the migration of smolts (Bass 2010).
 - Even gates upgraded to facilitate passage still delay the movements of both juvenile and adult fish significantly (Wright 2014 and 2016).

Results

- Finding 3: Life history diversity of some salmon species, such as coho salmon (*Oncorhynchus kisutch*), is greater than previously realized.



Results

- Finding 4: Best outcomes from comprehensive estuarine restoration projects not just tide gate upgrades (Hering 2010, Roegner et al 2010, Silver et al. 2015, Diefenderfer et al. 2016, Henderson et al. 2016).
 - Projects that reestablish connectivity and ecosystem processes are better than those focused on single objective (e.g., one species, water quality, etc.).

Results

- Finding 5: Tide gate upgrade/removal projects produce highly variable results.
 - The design and operation of these structures are important factors, but their location in the channel network and installation are equally important (Boys et al 2012, Johnson et al. 2013).



Results

- Finding 6: Many tide gate upgrades (i.e., drilling of small orifices, addition of pet doors, SRTs) by themselves do not improve fish passage (Johnson et al. 2008, Wright et al. 2014 and 2016, Greene et al 2012, Henderson et al. 2016).
- Finding 7: Impacts of tide gates on water quality and habitats well documented, but upgrade/replacement of tide gates with newer designs = mixed outcomes (Franklin and Hodges 2015, Boys et al. 2012).

Results

- Finding 8: Upgrading tide gates only first step in improving ecological conditions and fish migration corridors.
- Finding 9: Information on tide gate upgrade projects is limited due to lack of funding for monitoring and for publication in journals.

Recommendations

- 1. Besides Chinook salmon, coastal populations of coho salmon will benefit from increased passage opportunities and this consideration needs to be reflected in future tide gate designs, installations, upgrades or removal projects.
 - All anadromous and estuarine rearing species will benefit from improved connectivity and passage at locations where tide gates are installed.

Recommendations

- 2. Plan restoration actions with expectation that all desired ecological effects may not occur for several years after project completion.



Recommendations

- 3. Projects that deliver on water quality, fish recovery, agricultural conservation/flood protection, climate change resilience and/or consider recreational benefits are more likely to be locally acceptable and fundable (consider that due to their complexity they require coordinated management and, in many cases, multiple funding sources).

Recommendations

- 4. Work with stakeholder to develop integrated approach for identifying lands suitable for acquisition as part of comprehensive restoration strategy.
- 5. Optimum tide gate design and management requires a balance of: gate opening time and width, culvert size, invert elevation, and upstream pool depth at high tide.

Recommendations

- 6. Tide gates should be managed seasonally to ensure that fish passage requirements and water quality conditions are met at key times of year (migratory windows).
- 7. Develop and fund comprehensive monitoring strategies for key projects, implement them in partnership with research institutions (whenever possible), and include funding for publication of results in peer-reviewed literature.

Link to Full Report and Appendices

<https://inr.oregonstate.edu/biblio/ecological-effects-tide-gate-upgrade-or-removal-literature-review-and-knowledge-synthesis>

Google: (Institute for Natural Resources OSU + Tide Gates)

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